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Nocturnal blood pressure and 24-hour pulse pressure are potent indicators of mortality in hemodialysis patients

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Nocturnal blood pressure and 24-hour pulse pressure are potent indicators of mortality in hemodialysis patients.

Background. Cardiovascular (CV) complications are the leading cause of mortality in hemodialysis patients. The role of arterial hypertension on the prognosis of CV in hemodialysis patients is not as clear as in the general population. The purpose of this study was to investigate the prognostic role of ambulatory blood pressure (BP) on CV mortality in treated hypertensive hemodialysis patients.

Methods. Fifty-seven treated hypertensive hemodialysis patients (56.87 ± 16.22 years, 30 men) were prospectively studied. All patients initially underwent an ambulatory BP monitoring between two dialysis sessions. The outcome event studied was CV death; kidney transplantation and deaths not related to CV disease were censored.

Results. The duration of follow-up was 34.4 ± 20.39 months, during which 10 CV and 8 non-CV fatal events occurred. In the 10 patients who died from CV complications, age, previous CV events, ambulatory systolic BP, ambulatory pulse pressure (PP), and life-long smoking level were significantly higher, and the office diastolic BP was lower at the time of inclusion than in those who did not die from CV complications ($N = 47$). Based on Cox analysis and after adjustment for age, sex, and previous CV events, a low office diastolic BP [relative risk (RR) 0.49, 95% CI, 0.25 to 0.93, $P = 0.03$], an elevated 24-hour PP (RR 1.85, 95% CI, 1.28 to 2.65, $P = 0.009$), and an elevated nocturnal systolic BP (RR 1.41, 95% CI, 1.08 to 1.84, $P = 0.01$) were predictors of CV mortality (RR associated with a 10 mm Hg increase in BP and in PP).

Conclusion. This study demonstrates that nocturnal BP and 24-hour PP are independent predictors of CV mortality in treated hypertensive hemodialysis patients. Randomized trials are needed to investigate whether nocturnal BP and 24-hour PP are superior to office BP as targets for antihypertensive therapy in this high-risk group.

Key words: cardiovascular mortality, hemodialysis, hypertension, ambulatory blood pressure, pulse pressure.

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Mortality among hemodialysis patients remains high at 20% per year [1], and cardiovascular (CV) diseases are the leading cause of mortality in this population, accounting for 44% of overall mortality [2]. The probability of CV death is 50% after 10 years [3–6]. For hemodialysis patients aged 15 to 30 years, the incidence of CV death is 150 times greater than in the general population [7]. Although hypertension is a major CV risk factor in end-stage renal disease (ESRD) patients, its influence on the CV prognosis remains controversial. Whereas numerous reports show its deleterious influence on CV prognosis as in the general population, others find no relationship between hypertension and survival. Zager et al found a "U"-curve relationship between systolic blood pressure (BP) and mortality in dialysis patients [8]. A negative relationship between diastolic BP and CV mortality has been shown by Blacher et al [9]. In a longitudinal study by Kimura et al, no significant effect was found between BP and survival in older patients or in subjects with a previous history of CV complications; on the other hand, in hypercholesterolemic and in patients who smoked, elevated systolic BP significantly worsened the survival rate [10].

In essential hypertension, the CV prognosis is more closely associated with ambulatory BP than with clinic BP [11]. Moreover, the deleterious influence of an increased nocturnal BP on target organ damage and CV morbidity has been pointed out [11–13]. In ESRD patients, arterial hypertension is characterized by an altered circadian BP rhythm [14]. This lack of fall in nocturnal BP in hemodialysis patients could be related to an increased sympathetic nervous system activity [15, 16] caused by afferent renal reflexes. Also, a link between circadian BP impairment and arterial stiffness has been shown in ESRD patients [17]. The purpose of this study was to investigate the prognostic role of ambulatory BP and especially the influence of nighttime ambulatory BP on CV mortality in treated hypertensive hemodialysis patients.

METHODS

Patients

Fifty-seven patients on hemodialysis receiving antihypertensive therapy for more than six months were screened between 1993 and 1997. The dry weight was reached in all patients and was determined in a routine fashion on the basis of clinical examination. Patients with evidence of autonomic dysfunction, particularly orthostatic hypotension, and patients who were not able to support ambulatory BP monitoring were excluded. Patients with significant cardiac valvular disease, congestive heart failure with ventricular ejection fraction below 40%, or malignant disorders were also excluded. Eight patients were diabetic, and 22 had a past history of CV events. A previous history of CV complications was defined as follows: history of myocardial infarction, coronary bypass surgery or coronary angioplasty, angina pectoris, symptoms of peripheral vascular diseases, and cerebrovascular diseases (history of transient ischemic attacks, stroke). The follow-up ended in January of 1999. The duration of dialysis therapy was 6.0 ± 5.5 years. Patients were dialyzed three times per week. The duration of dialysis sessions was a four-hour minimum and was individually adjusted to control body fluids and blood chemistry. The dialysate was delivered by a system comprising bicarbonate delivery and ultrafiltration devices. An arteriovenous shunt was used in all patients. The quality of hemodialysis therapy was assessed by Kt/V index calculation during the month before the ambulatory BP measurement (ABPM).

Blood pressure measurements

Casual blood pressure. Office BP was measured between two dialysis sessions with a mercury sphygmomanometer with cuffs adapted to arm circumference in a sitting position according to the recommendations of the British Hypertension Society [18]. Controlled hypertension was defined as office BP $<$ 140/90 mm Hg.

Predialytic BP was measured by a nurse using a semiautomatic device, based on an oscillometric method (Dinamap/Critikon, Creteil, France) with the patients in the supine position after resting more than five minutes, before starting the dialysis session. In the absence of a universally accepted criterion, a predialytic BP of 150/90 mm Hg (equal or lower) was the cut-off point used to identify patients with adequate predialytic BP [19].

Ambulatory blood pressure measurements. An ABPM (SPACELABS 90207 monitor, Redmond, WA, USA) was performed between two dialysis sessions. BP was measured every 15 minutes during the daytime period (6 a.m. to 10 p.m.) and every 30 minutes during the nocturnal period (10 p.m. to 6 a.m.). The monitor was placed on the arm opposite the arteriovenous fistula. Subjects were allowed to follow their normal daily routine. Each time a reading was taken, subjects were instructed to remain motionless. The recorder automatically discarded false readings (for example, arm in motion or sound interference during recording). Recordings were included in the study only if at least 85% of the maximal number of 79 readings during the 24-hour period assessed the deletion criteria. Our study population was divided in two subgroups according to the magnitude of the nocturnal BP fall. Usual classification of nondipper (for example, a nocturnal BP fall of less than 10%) does not apply to hemodialysis population, and we defined nondippers by a night-day ratio of 100% or more for systolic or diastolic BP [14]. The remaining subjects were classified as dippers. The 24-hour ambulatory pulse pressure (PP; difference between 24-h systolic and diastolic BP) was calculated in all patients. The 24-hour ambulatory BP of 125/80 mm Hg (equal or lower) was the cut-off point used to identify patients with adequate ambulatory BP according to 1999 WHO/ISH guidelines [20].

Blood chemistry. Blood samples were drawn from the dialysis access after a 12-hour fast just before the start of hemodialysis. Phosphoremia, calcemia, and alkaline phosphatase levels were assayed by autoanalyzer (RA 1000; Technicon, Dumont, France) and serum-intact parathyroid hormone (PTH) by radioimmunoassay (Sorin Biomedica, Antony, France).

Analysis

The outcome event studied was CV mortality. CV deaths included ischemic heart disease, stroke, aortoiliac disease, congestive heart failure, and sudden deaths, defined as witnessed deaths that occurred within one hour after the onset of acute symptoms, with no evidence that violence or accident played any role in the fatal outcome. Causes of deaths were obtained from hospital records forms. We censored deaths that were not related to CV disease as well as kidney transplantation. Statistical analysis was performed on SAS statistical software (SAS Institute Inc., Cary, NC, USA). A difference was considered significant if the P value was below 0.05. The groups were compared with the two-sample t-test for continuous data and χ^2 test or Fisher's exact test for categorical data. We used different Cox proportional hazards models to determine the relative risks (RRs) of CV death. For casual and ambulatory BP, the RRs associated with a 10 mm Hg increase in BP were calculated. We conducted backward stepwise regressions in order to determine the confounding variables that had to be introduced into the multivariate models. Insofar as the number of CV deaths was very different between men and women in bivariate analysis, the variable "sex" was forced in each model. Also, the models were systematically age adjusted. Finally, the stepwise regressions were conducted to adjust our different models on age,

sex, and previous CV events. Survival curves were estimated using the Kaplan–Meier method and were compared with the log-rank test.

RESULTS

Study population

The duration of follow-up was 34.4 ± 20.39 months, during which 10 CV and 8 non-CV fatal events occurred. The eight patients (3 men) who died from non-CV deaths were older (67.87 ± 7.25 vs. 55.08 ± 16.61 years old, $P = 0.03$), had a lower total cholesterol level (4.33 ± 0.92 vs. 5.44 ± 1.05 mmol/L, $P = 0.01$), and tended to have a lower casual and ambulatory diastolic BP ($P < 0.1$), while nonsignificant differences in sex, office systolic BP, and ambulatory systolic BP were observed. Among CV deaths, one was attributed to stroke, one to aortic dissection, one to mesenteric infarction, two to sudden death, two following vascular surgery (aortic aneurysm), two related to congestive heart failure, and one to aortoiliac disease. The baseline characteristics of our cohort according to prognosis (CV death or not) are shown in Table 1. Age, sex, albuminemia, prevalence of previous CV complications, number of antihypertensive drugs, life-long smoking level, systolic ambulatory BP, and 24-hour ambulatory PP were significantly different between the two groups. Office and predialytic diastolic BP were significantly lower. Nondipper status tended to be more prevalent. Interdialytic weight gain, interdialytic weight variation, and epoetin dose tended to be higher in patients who died from CV diseases during the follow-up. No significant differences in heart rate, in the prevalence of controlled hypertension, and in the percentage of patients with adequate predialytic and ambulatory BP rates were observed between the two groups.

Hypertension control

Nineteen out of 57 (33.3%) patients had their hypertension controlled (office BP < 140/90 mm Hg). Controlled hypertensives had lower 24-hour, daytime, and nighttime BP than uncontrolled hypertensives, while a nonsignificant difference was observed in dipper status (Table 2). In 34 out of 57 (59.6%) patients and in 13 out of 57 (22.9%) patients, predialytic BP and ambulatory BP were, respectively, at goal (predialytic BP ≤ 150/90 mm Hg; 24-h ambulatory BP ≤ 125/80 mm Hg).

Predictors of CV mortality

Table 3 represents unadjusted relative risks of CV death in the study population. As assessed by Cox analysis, the significant predictors of CV mortality were: low diastolic BP, elevated 24-hour daytime, and nighttime ambulatory systolic BP, elevated 24-hour ambulatory PP and nondipper status. Figure 1 shows the probability of CV survival in dippers and nondippers. A comparison between survival curves was significant ($\chi^2 = 4.81$, $P = 0.03$). After an adjustment for age, sex, and previous CV events (Table 4), office diastolic BP (RR = 0.49, $P = 0.03$), 24-hour ambulatory PP (RR = 2.05, $P = 0.03$), and ambulatory nighttime systolic BP (RR = 1.41, $P = 0.01$) were significantly associated with CV mortality. The relative risk associated with a nondipper status was close to significance ($P = 0.06$).

DISCUSSION

Cardiovascular complications are the main cause of morbidity and mortality in ESRD patients. In a dialysis population, the overall risk of cardiac death increases by a factor of 5 to 20 [21]. From the U.S. Renal Data System [2] for the period from 1993 through 1995, the adjusted overall death rate for patients on dialysis was 243 deaths per 1000 patients years. Arterial hypertension represents the main CV risk factor in this population. Despite the fact that CV disease is the most common cause of death in hemodialysis patients, BP is poorly controlled in the majority. In a cohort of 649 hemodialysis patients, only 28% of subjects had controlled hypertension [22]. Rahman et al, in a study of 489 hemodialysis patients, found that 48% had an inadequate predialysis BP [23]. Using 24-hour ambulatory BP monitoring in 53 hypertensive hemodialysis patients, it has been shown that only 15% were at the goal level [24]. Closely related to these rates, 33% of our patients had their hypertension controlled, and the predialysis BP and ambulatory BP rates were at goal levels in 53 and 22% of patients, respectively. Hence, the poor BP control observed in our cohort does not differ from the situation usually described in hemodialysis patients, arguing for the usefulness of our results in the general hemodialysis population.

The influence of arterial hypertension on CV prognosis in ESRD patients is not as clear as in the general population. Degoulet, Legrain, and Reach showed an association between both systolic and diastolic BPs and CV mortality in 1453 prospectively studied dialysis patients [25]. Tomita, Kimura, and Inoue confirmed the prognostic role of systolic BP [26]. In a retrospective study by Duranti, Imperiali, and Sasdelli, no significant difference in survival was found between 168 normotensive and 202 hypertensive patients [27]. Moreover, the deleterious influence of low diastolic BP has been suggested in many reports. A "U" curve between systolic BP and CV prognosis has been found by Zager et al in a large longitudinal study [8]. Kimura et al showed that in patients with ischemic heart disease, survival curves were better in patients with high office systolic BP measurements than in normotensives [10]. A correlation between low diastolic BP, hypoalbuminemia, and risk of death has been established by Iseki et al in a cohort of 1243 chronic hemodialysis patients [28]. In agreement with

Table 1. Baseline characteristics of our study group according to prognosis

	Cardiovascular deaths $N = 10$	Others $N = 47$	P value
Age *years*	66.80 ± 6.94	54.77 ± 16.88	0.03
Sex *males/females*	9/1	21/26	0.01
Diabetes mellitus %	3 (30)	5 (10.64)	0.14
Dialysis duration before inclusion *years*	6.00 ± 5.55	5.19 ± 5.21	0.66
BMI kg/m^2	21.31 ± 3.06	23.32 ± 4.37	0.17
Life-long smoking level *pack/years*	22.90 ± 15.37	7.67 ± 15	0.005
Previous cardiovascular events %	9 (90.00)	13 (27.60)	0.0004
Interdialytic weight gain *kg*	2.46 ± 0.73	1.96 ± 0.79	0.07
Interdialytic weight variation %	4.15 ± 1.28	3.25 ± 1.39	0.06
Antihypertensive drugs			
Calcium channel blockers %	8 (80)	31 (65.96)	0.62
ACE inhibitors %	8 (80)	23 (48.94)	0.14
Beta blockers %	2 (20)	5 (10.64)	0.77
Central acting drugs %	2 (20)	4 (8.51)	0.61
Number of antihypertensive drugs	2.00 ± 0.81	1.36 ± 0.48	0.001
Monotherapy %	2 (20)	30 (63.83)	0.007
Hb *g/dL*	9.90 ± 1.29	9.88 ± 1.14	0.97
EPO therapy %	8 (80)	37 (82.22)	0.73
EPO dose *IU/kg/week*	121.77 ± 79.99	78.93 ± 61.88	0.06
Albuminemia *g/L*	37.30 ± 3.71	39.83 ± 3.52	0.04
Calcemia *mmol/L*	2.41 ± 0.39	2.28 ± 0.15	0.08
Phosphoremia *mmol/L*	1.98 ± 0.93	1.82 ± 0.67	0.51
Parathormone *pg/mL*	61.72 ± 61.2	131.95 ± 145.37	0.14
Alkaline phosphatase *IU/L*	180.1 ± 55.89	144.44 ± 50.60	0.05
Total cholesterol *mmol/L*	5.71 ± 1.50	5.22 ± 1.16	0.31
Triglycerides *mmol/L*	2.22 ± 0.82	1.74 ± 0.72	0.10
Kt/V	1.29 ± 0.14	1.30 ± 0.20	0.91
Office blood pressure			
Systolic blood pressure *mm Hg*	143.6 ± 16.86	145.04 ± 21.41	0.84
Diastolic blood pressure *mm Hg*	76.4 ± 10.34	85.83 ± 11.19	0.02
Controlled hypertensives %	4 (40)	15 (31.91)	0.72
Predialytic blood pressure			
Systolic blood pressure *mm Hg*	146.14 ± 23.67	143.6 ± 24.92	0.76
Diastolic blood pressure *mm Hg*	79.97 ± 13.17	68.5 ± 17.92	0.02
Patients with adequate predialytic blood pressure %	6 (60)	28 (59.57)	0.98
Ambulatory blood pressure			
24-hour systolic blood pressure *mm Hg*	152.22 ± 19.92	137.84 ± 15.72	0.02
24-hour diastolic blood pressure *mm Hg*	80.07 ± 12.93	82.18 ± 11.28	0.64
24-hour pulse pressure *mm Hg*	72.15 ± 15.14	55.71 ± 13.02	0.0009
24-hour heart rate *bpm*	78.8 ± 16.54	82.9 ± 11.96	0.36
Daytime systolic blood pressure *mm Hg*	153.7 ± 21.95	138.76 ± 16.16	0.02
Daytime diastolic blood pressure *mm Hg*	81.8 ± 15.25	83.21 ± 11.71	0.74
Nighttime systolic blood pressure *mm Hg*	158.7 ± 21.48	134.23 ± 18.85	0.0006
Nighttime diastolic blood pressure *mm Hg*	81.9 ± 12.78	77.89 ± 12.54	0.36
Dipper %	2 (20)	28 (59.57)	0.03
Patients with adequate ABP level %	1 (10)	13 (27.66)	0.23

Data are expressed as unadjusted mean ± standard deviation.

Abbreviations are: BMI, body mass index; ACE, angiotensin-converting enzyme; Hb, hemoglobulin; EPO, erythropoietin; Kt/V, dialysis dose; bpm, beats per minute.

our data, an association of both CV mortality and low diastolic BP already has been established by Blacher et al [9]. However, no significant relationship between diastolic ambulatory BP (nighttime, daytime, or 24-h diastolic BP) and CV prognosis was observed in our study group. This discrepancy also was not found in a general Japanese population in whom the prognostic significance of ambulatory BP versus screening BP has been studied [12]. However, ESRD patients differ from a general population particularly by the vascular disease [29] and the prevalence of circadian BP rhythm impairment. On the other hand, it could be hypothesized that office BP and predialytic BP measurements represent a pressor test, and that treated hypertensive dialysis patients with a lower pressor response triggered by the doctor in the office or by the nurse before fistula puncture are at greater CV risk. An underlying CV disease could be responsible for this lower pressor response. Standardized pressor tests need to be used to test this hypothesis.

Arterial hypertension in ESRD patients is characterized by an increased PP [30], and the role of aortic stiffness in these alterations in pulsatile arterial dynamics

Table 2. Ambulatory blood pressure in controlled and uncontrolled hypertensive subjects

	Controlled HT $N = 19$	Uncontrolled HT $N = 38$	P value
Office blood pressure			
Systolic blood pressure *mm Hg*	122.79 ± 13.31	155.78 ± 13.44	0.0001
Diastolic blood pressure *mm Hg*	74.95 ± 6.44	88.79 ± 10.77	0.0001
Ambulatory blood pressure			
24-hour systolic blood pressure *mm Hg*	129.89 ± 12.00	145.55 ± 17.21	0.0008
24-hour diastolic blood pressure *mm Hg*	77.89 ± 7.43	83.74 ± 12.79	0.07
24-hour pulse pressure *mm Hg*	52 ± 10.8	61.81 ± 15.33	0.36
24-hour heart rate *bpm*	81 ± 12.24	83.02 ± 13.23	0.58
Daytime systolic blood pressure *mm Hg*	131.63 ± 15.79	146.26 ± 17.24	0.003
Daytime diastolic blood pressure *mm Hg*	79.58 ± 9.56	84.66 ± 13.21	0.14
Nighttime systolic blood pressure *mm Hg*	128.89 ± 19.28	143.34 ± 20.87	0.01
Nighttime diastolic blood pressure *mm Hg*	73.95 ± 9.41	80.92 ± 13.39	0.05
Dippers %	11 (57.89)	19 (50)	0.57
Patients with adequate ABP level %	8 (42.11)	6 (15.79)	0.02

Abbreviations are: HT, hypertension; ABP, ambulatory blood pressure.

Table 3. Relative risk of cardiovascular death assessed by Cox proportional hazards models

	Relative risk (*95% confidence limits*)	P value
Office blood pressure		
Systolic BP	0.95 (0.69–1.31)	0.75
Diastolic blood pressure	0.43 (0.22–0.83)	0.01
Controlled vs. noncontrolled HT	0.59 (0.17–2.10)	0.42
Ambulatory blood pressure		
24-hour systolic blood pressure	1.61 (1.10–2.34)	0.01
24-hour diastolic blood pressure	0.88 (0.50–1.54)	0.66
24-hour pulse pressure	1.85 (1.28–2.65)	0.0009
Daytime systolic blood pressure	1.62 (1.12–2.36)	0.01
Daytime diastolic blood pressure	0.93 (0.55–1.58)	0.78
Nighttime systolic blood pressure	1.59 (1.21–2.08)	0.0008
Nighttime diastolic blood pressure	1.27 (0.79–2.05)	0.32
Nondippers versus dippers	4.81 (1.02–22.66)	0.05

HT is hypertension.

For continuous variables, relative risks of cardiovascular death associated with a 10 mm Hg increase in blood pressure and in pulse pressure are presented, whereas for binary variables, relative risks between the two groups are given.

Table 4. Adjusted relative risk of cardiovascular death assessed by multivariate Cox proportional hazards models (adjustments are made for age, sex, and cardiovascular history)

	Relative risk (*95% confidence limits*)	P value
Office blood pressure		
Systolic blood pressure	0.99 (0.77–1.28)	0.94
Diastolic blood pressure	0.49 (0.25–0.93)	0.03
Controlled versus noncontrolled HT	0.70 (0.19–2.49)	0.58
Ambulatory blood pressure		
24-hour systolic blood pressure	1.37 (0.95–1.96)	0.09
24-hour diastolic blood pressure	0.93 (0.48–1.82)	0.84
24-hour pulse pressure	2.05 (1.09–3.84)	0.03
Daytime systolic blood pressure	1.38 (0.97–1.96)	0.08
Daytime diastolic blood pressure	1.04 (0.57–1.91)	0.89
Nighttime systolic blood pressure	1.41 (1.08–1.84)	0.01
Nighttime diastolic blood pressure	1.40 (0.84–2.34)	0.19
Nondippers versus dippers	4.61 (0.97–21.99)	0.06

HT is hypertension.

For continuous variables, relative risks of cardiovascular death associated with a 10 mm Hg increase in blood pressure and in pulse pressure are presented, whereas for binary variables, relative risks between the two groups are given.

has been pointed out [31]. We showed that 24-hour PP is a prognostic factor of CV mortality in our cohort. With respect to mechanisms, elevated PP causes greater stretch of arteries and favors arterial damage. In a longitudinal study, Lakka et al showed that elevated PP accelerates the progression of preclinical atherosclerosis [32]. Moreover, elevated PP may be linked to high systolic BP, which favors left ventricular hypertrophy and increases myocardial oxygen demand, whereas the decrease in diastolic BP reduces the pressure on which coronary flow is dependent and together predispose the heart to ischemia. Longitudinal studies have widely shown that high PP values are a predictor of myocardial infarction in both normotensives and hypertensives [33, 34]. Also, Verdecchia et al demonstrated that ambulatory PP is a potent risk marker in untreated essential hypertensives [35]. In agreement with these data, we show that in treated hypertensive hemodialysis patients, 24-hour PP is a potent prognostic factor of CV mortality. Prospective studies are needed to assess the influence of antihypertensive treatment on CV prognosis through its effect on PP in this high-risk group.

The prognostic role of nondipper status on CV prognosis [11, 12] and the deleterious influence of nighttime systolic BP on target organ have been established [13].

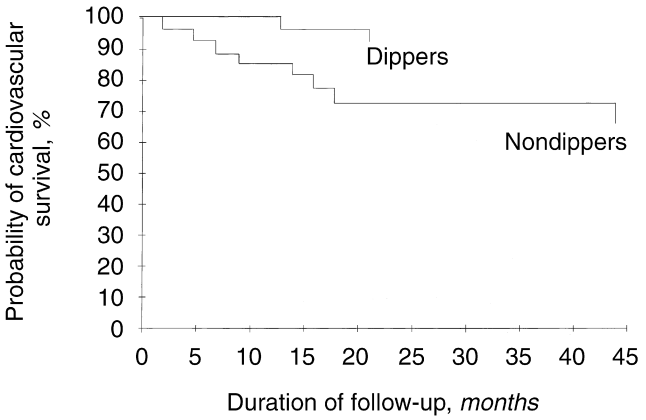

Fig. 1. Probability of cardiovascular (CV) survival according to the dipper status. The comparison between the survival curves was significant: $\chi^2 = 4.81$ ($P < 0.05$).

As in the essential hypertensive patients, our results suggest that nighttime BP levels may play a prominent role in CV prognosis in hypertensive dialysis patients. The influence of nighttime BP on CV morbidity could be even greater than in essential hypertensive patients, since arterial hypertension in dialysis patients is characterized by an altered circadian BP pattern. A nocturnal BP fall of less than 10% is usually used as the cut-off point in identifying nondippers in essential hypertension [11]. This cut-off point is not relevant in such a population of ESRD patients: Only 6 out of 57 (8.7%) showed a nocturnal decrease higher than 10%, and 27 (47.3%) had an absent or an inversed nycthemeral BP rhythm. These data emphasize the great prevalence of nondipping status in dialysis hypertensive patients [14]. However, the prevalence of nondippers was not significantly different between controlled and uncontrolled patients. These results suggest the lack of efficacy of the antihypertensive strategy designed to control office BP to restore nycthemeral BP rhythm. They also emphasize that some patients with high nighttime systolic BP could not be identified by casual BP values, while ambulatory BP recordings could identify hypertensive patients at high vascular risk. A therapeutic strategy based on ambulatory BP measurements is suggested in this high risk population. Since dipper status and nighttime systolic BP load are closely related, whether the loss of circadian rhythm is a more important indicator than the duration of elevated systolic pressure cannot be easily determined. However, after an adjustment for age, sex, and history of CV complications, nighttime systolic BP was associated with CV prognosis, while dipper status failed to reach statistical significance, suggesting that nighttime systolic BP is probably a more potent indicator.

The great prevalence of nondippers in treated dialyzed hypertensive patients and the prognostic role of nocturnal BP emphasize the usefulness of ambulatory BP monitoring in nephrology. The prognostic role of nighttime BP and of 24-hour PP on CV mortality suggests investigating whether nocturnal BP and 24-hour PP are superior to office BP as targets for antihypertensive therapy in hypertensive hemodialysis patients in prospective randomized trials.

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